REMARKS

Claims 1-3, 5-6 and 10-21 are pending in the application.

Claims 1, 18 and 19 are amended above to overcome the examiner's section 101 rejection.

Claims 1, 3, 5-6, 11-12, 14-19 and 21 are amended above to more clearly set forth what the applicant regards as the invention.

No new matter is added to the application by way of these claim amendments.

I. THE SECTION 101 REJECTION OF ALL CLAIMS

The examiner rejected claims 1-3, 5-6, 10-13 and 18-21 because independent claims 1, 18 and 19 fail to recite a statutory class of invention.

The examiner's rejection is overcome by amending claims 1, 18 and 19 above to direct them to methods that are performed "using a computer apparatus".

II. TRAVERSE OF THE OBVIOUSNESS REJECTIONS

The examiner has rejected all application claims for obviousness over Stetson in view of Lee or over Lee in view of Stetson.

Before traversing these rejections, the Applicant notes that there appears to be an error in the examiner's remarks related to the Stetson in view of Lee rejection. On page 5 of the Official Action, lines 1 to 3, the examiner states that Stetson discloses "expressing the composite signal as a matrix X having rows each of which is a respective segment of signal amplitude values and corresponds to a length of time associated with a signal cyclet". This statement is then contradicted on the same page at lines 10-11, which states "Stetson does not explicitly disclose these value corresponds *(sic)* to a length of time associated with a signal cyclet". Moreover, Lee is cited by the examiner to remedy Stetson's alleged shortcoming in this regard. The Applicant believes that the examiner intended to delete the phrase "having rows each of which is a respective segment of signal amplitude values and corresponds to a length of time associated with a signal cyclet" from page 5 lines 1-3, and the Applicant so assumes below.

As will be discussed in more detail below, all pending claims are believed to be non-obvious and patentable for at least the reasons recited below.

A. Stetson in View of Lee – Claims 1-3, 5-6 and 10-17

The examiner rejected claims 1-3, 5-6 and 10-17 under 35 U.S.C. 103 for being obvious over Stetson (US Patent 6,701,170) in view of Lee (U.S. Patent 6,799,170). Of the rejected claims, claim 1 and 14-17 are independent.

1. All claims are non-obvious and patentable

Regarding independent claims 1, 14 and 16, the examiner states that Stetson discloses a method and computer apparatus for separating a plurality of source signals from a composite signal expressed as a series of values of signal amplitude, each source signal having a respective period similar or equal to p, the method comprising the steps (Fig. 1 and Fig. 3) of:

a) expressing the composite signal as a matrix X (Col. 5, lines 20 - 26);

b) implementing a decomposition of the matrix X by decorrelation and normalisation to obtain decomposition results (Col. 6, lines 64 - 67);

c) performing independent component analysis (ICA) of the decomposition results to obtain at least one of estimated separated signal modulation envelopes and estimated separated signal cyclets (Col. 7, lines 32 - 67).

Here the examiner's position regarding claim step c) is incorrect. Stetson does not "obtain at least one of estimated separated signal modulation envelopes and estimated separated signal cyclets" at Col. 7, lines 32 – 67 or anywhere else. It is important to appreciate that Stetson is carrying out conventional Blind Source (or Signal) Separation, which, as is well known, yields signals which are complete and separated. The Blind Source Separation taught by Stetson does not yield signal attributes and/or parts such as their modulation envelopes or cyclets. (See, e.g, Stetson Col. 8 lines 4-7, which refers to the plethysmographic signal and the interference signal being obtained).

Applicant's claimed invention is not conventional Blind Source Separation. The claimed methods do not recover separated signals. Instead, the methods of claims 1, 14 and 16 as well as independent claims 15 and 17 recover signal attributes and/or parts of signals, i.e. modulation envelopes and/or cyclets. To accomplish this, Applicants' invention processes a matrix with rows corresponding to cyclet length, not simply rows which are signal mixtures unrelated to cyclet length as disclosed in Stetson.

The examiner notes that Stetson discloses a composite signal as a matrix having rows x(t), having an amplitude value as a signal, which is a function of time but Stetson does not

explicitly disclose these value corresponds *(sic)* to a length of time associated with a signal cyclet. The examiner goes on to state that Lee teaches a matrix having rows x(t) having values correspond *(sic)* to a length of time with signal cyclet *(sic)*, and cites Figure 1 and Col. 4, lines 58 – 67 in this regard. However, neither Lee Figure 1 nor Col. 4, lines 58 – 67 have anything remotely to do with signal cyclets. Figure 1 is simply a drawing of signal sources, signal sensors and data output from the sensors. Moreover, Col. 4, lines 58 – 67 is a discussion of the numbers of sources and sensors, stating that ICA works there are at least as many sensors as sources, but not if there are fewer. The cited extract is, therefore, not remotely related to signal cyclets. For these reasons, independent claims 1 and 14-17 are non-obvious and patentable over Stetson in view of Lee. Independent claims 2-3, 5-6, and 10-13 are non-obvious and patentable at least by virtue of their dependence upon claim 1.

2. Claim 2 is independently patentable

Claim 2 is independently non-obvious and patentable. Regarding claim 2, the examiner states that Stetson discloses a method according to claim 1 including the step of estimating source signal period p by synchronous averaging of the composite signal. (Citing col. 5, lines 30 - 35 of Stetson). But the examiner has already acknowledged that Stetson does not disclose a method according to claim 1, and cites Lee to remedy the deficiency. Applicant will assume that the examiner intended to state Stetson in view of Lee discloses a method according to claim 1.[1] The examiner goes on to state that Stetson discloses the step of estimating source signal period p by synchronous averaging of the composite signal, and cites Stetson Col. 5, lines 30-35. The examiner's position is respectfully traversed because Stetson does not disclose estimating source signal period p at Col. 5, lines 30-35, as discussed in Applicant's response to the previous Official Action. Instead Stetson Col. 5, lines 30 -35 discloses a parameter p(s) which is a probability distribution function - Col. 5, line 36 repeated here for convenience - "where p(s) is the probability distribution function of s". The equation for *p(s)* in Col. 5, line 33 is as follows:

$$p(s) = p(s_1 \ldots\ldots s_m) = \prod_{i=1}^{m} p_i(s_i)$$

[1] To avoid repetition, in later claims, where the Examiner states Stetson or Lee discloses a method according to a claim, Applicant will assume that the Examiner intended to state Stetson in view of Lee or Lee in view of Stetson (as appropriate) discloses a method according to the claim without further comment in this regard.

which is the familiar criterion for statistical independence of signals, i.e. that one can factorise the probability distribution function of s into a product of individual probability distribution functions $p(s_i)$ (i = 1 to m) of signals s_1 to s_m in s. Clearly, a probability distribution function is completely different to the claimed source signal period. The fact that Stetson uses the letter p to designate a probability distribution function does not make it read on to Applicant's source signal period which is coincidentally designated by the same letter. For at least these reasons, claim 2 is independently non-obvious and patentable.

3. Claim 3 is independently patentable

Claim 3 is further independently non-obvious and patentable. In particular, Stetson does not disclose – as the examiner maintains - performing ICA upon an SVD decomposition product of the matrix. In particular, Stetson does not disclose obtaining a matrix containing estimated separated signal modulation envelopes or estimated separated cyclets as claimed in claim 3. Instead, Stetson Col. 6, lines 64-67 simply discloses conventional SVD of multiple signal mixtures x(t). (See Stetson at Col. 5 lines 21-24, and Col. 7, lines 32-67 which simply disclose conventional ICA of the SVD results). For at least these reasons, claim 3 is independently non-obvious and patentable.

4. Claims 5-6 are independently patentable

Claims 5-6 are independently non-obvious and patentable. Claims 5 and 6 relate to performing ICA on a singular vector matrix according to whether the signal modulation envelopes or the cyclets are more statistically independent and obtaining an independent component matrix containing estimated separated signal envelopes and a matrix containing estimated separated cyclets. The examiner regards Stetson Col. 7, lines 32 -67 as disclosing these features of claims 5 and 6. The examiner's position is respectfully traversed because that Stetson extract discloses only conventional ICA of SVD results giving rise to separated signals, not signal attributes such as signal modulation envelopes or cyclets as claimed.

5. Claim 10 is independently patentable

Claim 10 is independently non-obvious and patentable. Regarding claim 10, the examiner states that Stetson discloses a method according to claim 1 wherein the composite signal is detected by a single sensor – a photodetector. (Citing Figure 1 feature 110). It should be noted that the photodetector is actually feature 114 of Figure 1. The examiner's rejection of

claim 10 is respectfully traversed because photodetector 114 operates on a minimum of two wavelengths and, therefore, must be equivalent to at least two independent sensors. (See, e.g., Stetson at Col. 6, lines 33-35, 41-44, 52-58). As regards Col. 6, lines 52-58 in particular, it is impossible to obtain two principal components from one conventionally obtained and processed signal from one photodetector.

6. Claim 11 is independently patentable

Claim 11 is independently non-obvious and patentable. The examiner's rejection of claim 11 appears to be based upon confusing two different concepts. Stetson discloses detecting the source signals using a plurality of sensors. (See, e.g., Stetson at Col. 1, lines 64 -67, Col. 5, lines 20 - 26 and Col. 6, lines 64 - 67). But in Stetson, all sensor signals (mixture signals) are combined into one matrix for processing. (See, e.g., Stetson at Col. 5, lines 25 – 26 – "x(t) is a matrix of a set of observed signals (mixed signals)"). Claim 11 is directed to something different. In particular, claim 11 requires that each composite signal give a respective matrix for analysis, so there are as many matrices as there are composite signals and not a single data matrix containing all the composite signals as in Stetson.

Claim 11 relates to the situation described in Applicant's specification at page 30 lines 16-30, where a composite periodic signal arrives at different times at different sensors. Different sensor outputs can be considered as consisting of replicas of the periodic signal with different noise, attenuation and also time delays, the latter two both being caused by the different propagation paths to the sensor. Partitioning to use segments from all channels in the input matrix cannot be exploited in this case. The time delays on different channels will mean that cyclet replicas from different channel recordings would be misaligned within a single matrix. Consequently, in the situation envisaged in claim 11, Stetson's one data matrix containing all the composite signals would not work. Moreover, Stetson does not disclose the matrix being obtained from a composite signal partitioned on the basis of cyclets. For at least this reason, claim 11 is independently non-obvious and patentable.

7. Claim 12 is independently patentable

Regarding claim 12, the examiner states that Stetson discloses detecting the source signals are detected by using a plurality of sensors providing respective composite signals, and the matrix is obtained from the composite signals collectively. (Citing Stetson Col. 1, lines 64 -

67, Col. 5, lines 20 - 26 and Col. 6, lines 64 - 67). However, Stetson does not disclose the matrix being obtained from a composite signal which is partitioned on the basis of cyclets. Claim 12 relates to a case referred to as instantaneous mixing, in which different sensor outputs can be considered as consisting of replicas of the composite periodic signal without relative delay but with different additive noise and different attenuations. (See Applicant's specification at page 30 lines 1-15). Claim 12 is independently non-obvious for at least this reason.

8. Claim 13 is independently patentable

Claim 13 is independently non-obvious at least because Stetson does not disclose the separated signal modulation envelopes and/or the separated signal cyclets are analyzed for indications as to the condition of respective apparatus sources. The portions of Stetson cited by the examiner for disclosing this claim 13 feature - Fig. 1, Col. 4, lines 33-60 – actually discloses only a standard system. Moreover, cited Stetson Col. 6, lines 64-67 and Col. 7, lines.32-67 disclose SVD and ICA using conventional data and not a matrix obtained from a composite signal partitioned on the basis of cyclets as claimed.

9. Claims 15 and 17 are independently patentable

Independent claims 15 and 17 are independently non-obvious and patentable for several reasons. Firstly, claims 15 and 17 are non-obvious because the cited prior art does not disclose source signals having periodicities similar or equal to p as claimed. The examiner points to Stetson Figure 3 for reciting this feature. However, in Stetson Figure 3, each signal has two very different periodicities for a low amplitude region and a high amplitude region, approximately 50 time units and 20 time units respectively (no time calibration is given by Stetson) - so one is 150% bigger than the other. The examiner's reference to Col. 6, lines 45 – 50 for disclosing this feature is not understood as it relates to a photocurrent graph, not to a computer or software.

Claims 15 and 17 are also non-obvious because the cited prior art does not disclose the claimed step (a) of partitioning a composite signal into a plurality of partition matrices having rows each of which is a respective segment of signal amplitude values and corresponds to a length of time associated with a signal cyclet. The examiner states that Stetson discloses a composite signal as a matrix having rows x(t), having an amplitude value as a signal, which is a function of time but acknowledges that Stetson does not explicitly disclose these value corresponds *(sic)* to a length of time associated with a signal cyclet. The examiner goes on to

state that Lee teaches a matrix having rows x(t) having values correspond *(sic)* to a length of time with signal cyclet *(sic)*, and cites Figure 1 and Col. 4, lines 58 – 67 in this regard. As has been said, neither Lee Figure 1 nor Col. 4, lines 58 – 67 have anything remotely to do with signal cyclets: Figure 1 is simply a drawing of signal sources, signal sensors and data output from the sensors; moreover, Col. 4, lines 58-67 is a discussion of the relative numbers of sources and sensors - it does not refer to signal cyclets or anything related to signal cyclets.

Moreover, because Stetson Col. 5, lines 20 – 26 does not disclose partitioning a composite signal into a plurality of partition matrices as above, it does not disclose performing an SVD of at least one such matrix. Col. 6, lines 64 – 67 merely discloses SVD of conventional data. Finally, the cited prior art does not disclose a matrix partitioned in accordance with the estimated period p, so there can be no independent component matrix or associated component matrix derived from it as claimed in step (d) of claims 15 and 17. Consequently there are no estimated separated signal modulation envelopes or estimated separated cyclets contained in such component matrices again as claimed in step (d) of claims 15 and 17.

For each of these reasons, independent claims 15 and 17 are independently non-obvious and patentable over the cited prior art.

B. Lee in View of Stetson – Claims 18-21

Claims 18 -21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lee in view of Stetson.

Independent claim 18 is non-obvious and patentable on a variety of grounds. Regarding the independent claim 18 preamble, Lee does not disclose each source signal having a respective period similar or equal to p. Figures 9A and 9B are speech signals from different microphones monitoring a conversation, and the periodicity clearly varies considerably as voices change in pitch.

Lee Col. 4, line 58 - Col. 5, line 35 discloses numbers of sources and sensors, a series of observations of the sources by the sensors – e.g. monitoring human voices using microphones, and collecting digital data vectors from the observations. However, there is no disclosure of expressing the composite signal as a trial matrix having rows each of which is a respective segment of signal amplitude values and corresponds to a length of time associated with a signal cyclet with a trial period p' as claim 18 requires. Indeed, as mentioned above human voices vary

considerably in pitch and will not have a common cyclet period, so Lee teaches away from such a period.

The examiner acknowledges that Lee does not expressly disclose step (b), i.e. implementing a singular value decomposition of the trial matrix to generate two singular vector matrices and a singular value matrix, each trial matrix having a probability associated with its decomposition. Since Lee does not disclose (b), Lee cannot disclose iterating steps (a) and (b). Moreover, Col. 2, lines 20 -25, describes a completely different iteration process to define multiple classes for a data set, each class having a set of mixing parameters including a mixing matrix A_k and a bias vector b_k. This extract from Lee has nothing whatsoever to do with generating versions of the trial matrix for a series of different values of the trial period p' as required by claim 18 step (c);

Further while Lee Col. 5, lines 47 -67 describes a conventional ICA method performed on signal mixtures in the normal way (Col. 5 lines 37-39), there is no disclosure of ICA of SVD results from a maximum probability trial matrix with a signal cyclet of trial period p' taken to be the period p subject to this period not corresponding to a multiple of a true period as per 18(d).

Next, the examiner states that Stetson teaches claim step 18(b) at Col. 6, lines 64 - Col. 7, lines 12. This is not correct as Col. 6, line 64 - Col. 7, line 12 simply discloses obtaining two principal components for data from two wavelengths. There is no disclosure of SVD of a trial matrix having rows corresponding to a length of time associated with a signal cyclet (see step 18(a)) and also having a probability associated with its decomposition. Therefore, the obviousness rejection of claim 18 over Lee in view of Stetson is respectfully traversed.

Finally, the examiner's reference to Stetson Col. 3, lines 28-33 is not understood: this extract relates to "minimizing a function of the higher-order cross-correlation of the data" – here a higher-order cross-correlation is not a decomposition-associated probability and "the data" is not a trial matrix with cyclet-related rows.

Independent claim 19 is also non-obvious and patentable. Regarding claim 19, the examiner states that Lee discloses a method (Figure 1) of separating a plurality of source signals (121,122,102 etc) from a composite signal (101) expressed as a series of values of signal amplitude: this is wrong – 101 and 102 are sources, and 121 and122 are sensors (also 123) – see Col. 4 lines 45-49. The examiner goes on to state that each source signal having a respective

period similar or equal to p, which is also wrong: as has been said, Lee Col. 5, lines 6-12 discloses monitoring human voices which vary will considerably in pitch and will not have a common cyclet period, so Lee teaches away from such a period.

Claim 19 is also non-obvious because the cited prior art does not disclose expressing the composite signal as a matrix having rows each of which is a respective segment of signal amplitude values and corresponds to a length of time associated with a signal cyclet. This is because Lee is concerned with variable pitch, and therefore different cyclet lengths in a data matrix to be processed to separate signals. The portion of Lee cited for disclosing this claim feature - Col. 4, line 58 - Col. 5, line 35 - discloses numbers of sources and sensors, a series of observations of the sources by the sensors – e.g. monitoring with microphones, and collecting digital data vectors from the observations.

The cited prior art also does not disclose estimating a number q of source signals with periodicities similar or equal to p present within the composite signal and reducing the decomposition results in accordance with such number of step (c) of claim 19. Lee Col. 4, lines 58 -67 which is cited for teaching this step actually discloses estimating the number of sources to determine whether or not ICA will work, because ICA requires at least as many sensors as sources. However, the Lee excerpt has nothing whatsoever to do with estimating the number of source signals with similar periodicities present within the composite signal, or with reducing the decomposition results in accordance with such number.

The cited prior art also does not disclose "performing independent component analysis (ICA) of the decomposition results to obtain at least one of estimated separated signal modulation envelopes and estimated separated signal cyclets" of claim 19 step (d). Lee Col. 5, lines 47 -67, which is cited for teaching this feature actually discloses conventional ICA of a series of observations.

The examiner acknowledges that Lee does not expressly disclose step (b), i.e. implementing a decomposition of the matrix by decorrelation and normalisation to obtain decomposition results. The examiner states that Stetson Col. 6, lines 64 -67 supplies the missing teaching. This is not correct. Col. 6, lines 64 - 67 of Stetson simply discloses obtaining two principal components for data from two wavelengths. There is no disclosure of decomposition of a matrix having rows corresponding to a length of time associated with a signal cyclet (see 19(a)). Therefore, the obviousness rejection of claim 19 over Lee in view of Stetson is

respectfully traversed. Claims 20-21 are non-obvious at least by virtue of their dependence upon claim 19.

As has been noted in relation to claim 18, the examiner's reference to Stetson Col. 3, lines 28 -33 is not understood: this extract relates to "minimizing a function of the higher-order cross-correlation of the data" – here a higher-order cross-correlation is not a decomposition-associated probability and "the data" is not a trial matrix Xtest with cyclet-related rows.

Claim 20 is independently non-obvious and patentable. Regarding claim 20, Lee does not disclose the number q of source signals with similar periodicities being estimated from the source signals' origins, because the cited excerpt of Lee at Col. 4, lines 58-67 does not mention signal periodicity or any related quantity.

Regarding claim 21, Lee does not disclose the number q of source signals with similar periodicities being estimated from a number of elements of a singular value matrix A, the elements having values exceeding a threshold value. The cited Lee excerpt - Col. 13, lines 30-39 - does not mention signal periodicity, a matrix, or any related quantity. Instead, it mentions little more than class probabilities, sample block size, ICA and signal to noise ratio. Indeed, the reference to Col. 13, lines 30-39 of Lee could be a typographical error because the excerpt seems to be completely irrelevant to claim 21 and it begins and ends part way through a sentence.

C. The Claims are Non-Obvious Because the Combination of References is not Rational or Logical

According to MPEP §§ 2142 and 2143, it is the examiner's burden to establish a *prima facie* case of obviousness by clearly articulating reasons with rational factual underpinnings to support the conclusion of obviousness. This includes establishing rational reasons for combining prior art references. Stetson and Lee are not properly combined because the combination is not rational at least because one of skill in the art at the time of the invention would understand that the references relate to incompatible techniques and circumstances. Stetson relates to conventional Blind Source Separation using independent component analysis (ICA), i.e. ICA which is workable – see e.g. Col. 7 lines 32-35. Lee relates to the situation when ICA does not work: see Col. 5 lines 62-67, where Lee states that ICA does not work if the sources are not independent or if they move location. Col 6 lines 1-5 then indicates that Lee's algorithm allows signals to be non-independent and movement of sources.

As noted in US published patent application No. 2005/0105644, conventional Blind Source Separation requires source signals to be statistically independent and to exhibit stationarity and linearity. Stationarity means that signals and channels in which they mix do not change while signal mixtures are sampled. Linearity means that mixtures of signals received by sensors are linear combinations of those signals. Thus, one skilled in the art at the time of the invention would understand that Stetson and Lee disclose methods that are used in different situations – Stetson where ICA is workable and Lee where ICA is not workable. Therefore, the combination of the references is not rational or logical and all claims are non-obvious and patentable.

CONCLUSION

Claims 1-3, 5-6 and 10-21 are pending in the application and are believed to be patentable for the reasons recited above. Favorable reconsideration and allowance of all pending application claims is courteously solicited.

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